

Remarks/Arguments

Claims 1-14 were pending in the application. A restriction requirement was made between the apparatus invention of claims 1-9 and the method invention of claims 10-14. Applicants' attorney, R. Kelly, elected the invention of method claims 10-14 without traverse, which election is affirmed herewith. Claims 1-9 have now been withdrawn from further consideration in the present application. Claims 10 – 14 remained in the application for examination and were rejected by the Office Action of Feb. 2, 2004.

Claim 10 has been amended herewith to further define the novel aspects of the invention by incorporating therein some of the catalyst-specific limitations previously appearing in claim 11. Claim 11 has been canceled herewith, and the remaining limitations of former claim 11 now appear partly in new claim 16 and the remainder in claim 17. Claims 12 and 13 each depend from new claim 17 and in that regard are the similar to when they depended from claim 11, with the exception that claim 12 is now limited to a quantity of oxygen "less than about 0.2 mol%" of the process gas. Claim 14 depends from amended claim 10 and has been corrected to include the missing period at its end. New claim 15 is similar to claim 14 but omits the recitation that the oxidation reaction effected by the addition of oxygen is necessarily for the specific purpose of converting carbon monoxide. Indeed, the added recitation in claims 14 and 15 that the supplied oxygen effects an oxidation reaction serves by differentiation to emphasize that the addition of oxygen in claim 10 (and claim 18) may evoke reactions and/or mechanisms other than and/or in addition to an oxidation reaction in treating the process fuel gas, as disclosed at page 4, lines 32-34, page 7, lines 31-34, and page 15, lines 4-7. Further, a new independent claim 18 includes all of the limitations of former claim 10 as well as the limited quantity of oxygen recited in claim 12, to wit, "less than about 0.2 mol%" of the process gas.

Accordingly, claims 10-18 are now in the application and are under examination.

The total number of claims, particularly in light of the withdrawn claims 1-9, is 20 or fewer and the number of independent claims is 3 or fewer. Accordingly, there should be no requirement to pay any additional fee for the added claims; however the USPTO is authorized to charge any extra fees to Deposit Acct. 50-1307 per the accompanying fee transmittal letter.

Reference is now made to the rejection of the claims in the Office Action and further, to the modifications of the claims via the accompanying amendments. Claims 10 and 14 had been rejected as anticipated under 35 USC 102 by the Aoyama et al reference (JP2000-203804=US 6,455,008). The Aoyama et al reference (hereinafter Aoyama) discloses a system similar to that of original claim 10 in many respects; however that reference was clearly concerned only with the use of a copper-zinc catalyst for the water gas shift (WGS) reactor and with quantities of supplemental oxygen that were 0.2 % or greater of the total process gas. For those reasons, neither the amended claim 10 nor the new independent claim 18 is anticipated by the Aoyama reference.

The Aoyama reference discloses only the use of a copper-zinc catalyst for performing its water gas shift (WGS) reaction. Moreover, in the cited experimental example in that reference (at Col 6, lines 30-50 of US 6,455,008), only a very small quantity of that Cu/ZnO was used in the experiment. Applicants respectfully submit that Cu/ZnO, particularly in practical-sized quantities greater than used in the Aoyama experiments, are in an oxidized state and must be reduced prior to being placed in service. Indeed, the reduction process must be carefully conducted, since this reaction is exothermic and subject to runaway temperatures. Before removing the reduced Cu/ZnO from the reactor, it must also be very carefully oxidized since the heat of oxidation for $\text{Cu} + \text{O}_2 \rightarrow \text{CuO}_2$ is also very exothermic and subject to runaway temperatures. It is for these reasons that Applicants doubt and challenge the applicability of Cu/ZnO as a WGS catalyst, with the further addition of supplemental O_2 , to other than a small-scale experiment.

Applicants, on the other hand, have disclosed and claimed (claims 10 and 16 as amended) the use of a WGS catalyst "selected from one or more metals from the group

consisting of the noble metals and the group of non-noble metals consisting of chromium, manganese, iron, cobalt, and nickel”, and preferably further, “wherein the one or more metals of the catalyst bed have a promoted support, the promoted support comprising at least a metal oxide” (claim 16). Use of such catalysts for the WGS reaction afford a low temperature operation and avoid the delicate reduction and oxidation requirements otherwise associated with a catalyst such as Cu/ZnO.

Further, the Aoyama reference states, also at the passage cited above, that it seeks the addition of oxygen to the WGS reaction at a level greater than is preferred and now claimed in claims 12 and 18 of the present application. Specifically, Aoyama seeks a molar ratio of $[O]/[CO]$ that is equal or preferably greater than 0.05 (i.e., 1/20). Since the CO is said to be about 10% of the total “model gas”, then the percentage of O to the total gas of Aoyama (in mol %, as Applicants have chosen to use) would be at least 0.2 mol% (i.e., 1/20th of 10%) and preferably greater. Conversely, the preferred quantity of oxygen added to Applicants’ WGS process is “less than about 0.2 mol %” (page 12, lines 34-36 of the application). Thus Applicants disclose and claim (in Claims 12 and 18) a range of O₂ addition that is clearly less than the higher range preferred by Aoyama. This distinction is significant in the capacities of the delivery systems required to supply the supplemental O₂ to the WGS reaction.

The Examiner noted the deficiencies of the Aoyama reference with respect to the Applicants’ claims to different WGS catalysts and/or quantities of O₂, and sought to overcome them by suggesting obviousness under 35 USC 103 in view of the teachings of either Ernest et al or Krumpelt et al. Applicants respectfully reject the appropriateness of any such combination for the following reasons. Firstly, it is important to note that catalysts, the reactions which they facilitate, and catalyst chemistry as a whole, is a complex area and does not lend itself to simple substitutions. Catalysts of a particular composition that work in one way in one chemical and/or thermal environment may not be readily substituted into other different situations with a high degree of predictability, and vice versa. For that reason, it is not obvious to substitute one catalyst for another in a

particular situation just because there is some tenuous thread of commonality between the applications or conditions or catalyst composition.

The Aoyama reference envisions use of a Cu/ZnO catalyst in a WGS reaction in a 200 - 400 °C range. Applicants envision use of a different catalyst (typically noble metal) for the WGS reaction in a similar temperature range less than about 400 °C. On the other hand, the Ernest reference is concerned with the composition and manufacture of a catalyst capable of operating in extremely high temperatures, such as in excess of 1300 °C. Indeed, the Ernest reference seems to be concerned only with operating at such elevated temperatures, and Applicants fail to see any suggestion therein of operating the Ernest catalyst in either Aoyama's or the Applicants' thermal environments, regardless of its composition.


The Krumpelt et al reference is yet another instance of a catalyst that, while it may be similar in gross composition to that of claims 10 and 16 of the present application, simply is not intended nor suggested for use in the applications of either the present invention or the Aoyama reference. Whereas the present invention and the Aoyama reference are concerned with using supplemental oxygen with a respective particular catalyst in a WGS reaction, the Krumpelt reference is concerned with using a catalyst very different from that of the Aoyama catalyst, and as a partial oxidation catalyst in the reformation process rather than in a WGS reaction, and at a temperature "not less than about 400 °C".

It is respectfully submitted that there is nothing obvious about taking the particular catalysts (noble metal based) of either Ernest or Krumpelt and substituting them in Aoyama in a different (WGS) reaction for a very different catalyst (Cu/ZnO) and operating at significantly different temperatures (typically less than 350 - 400 °C) to arrive at the inventive method claimed by Applicants. Accordingly, it is respectfully submitted that the claims, as now amended, clearly and patentably distinguish over any appropriate combination of teachings contained in the applied references. Entry of this amendment, and favorable reconsideration and an indication of allowance are respectfully requested. In the event issues remain and the Examiner feels the prosecution

might be advanced by further discussion, the Examiner is respectfully requested to contact applicants' attorney at the number below.

Respectfully submitted,

Tianli Zhu, et al

By: 
Stephen A. Schneeberger
Reg. No. 25,434

49 Arlington Road
West Hartford, CT 06107
Tel: (860) 313-4402
Fax: (860) 313-4402
Date: April 15, 2004